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Professor Kurt E. Oughstun

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The research funded by your office on pulsed electromagnetic beam fields is nearing completion with some rather interesting results. In particular, the rigorous angular spectrum representation of pulsed beam fields has been found to differ from that given by the simpler plane-wave spectrum representation. This latter formulation [as given by W. H. Carter, "Electromagnetic Beam Fields," Optica Acta, 21, 871-892 (1974)] assumes the form of the propagated transverse field components for either the electric or magnetic field vector and then solves the Maxwell field equation for the remaining field components in a self-consistent manner. The rigorous derivation for a general pulsed electromagnetic beam field clearly shows that this assumption is valid only for very special cases of the spatial field distribution and polarization state.

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April 19, 1989

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Dear Drs. Albanese and Nachman:

This letter closes off my 1988 AFOSR sponsored research on dispersive electromagnetic pulse propagation phenomena. The research funded under Contract #F49620-85-C-0013 has been documented in the two papers:

S. Shen and K.E. Oughstun, "Dispersive Pulse Propagation in a Double Resonance Lorentz Medium," Journal of the Optical Society of America B (to be published, 1989).

P. Wyns, D.P. Foty, and K.E. Oughstun, "Numerical Analysis of the Precursor Fields in Linear Dispersive Pulse Propagation," Journal of the Optical Society of America A, Feature Issue on Mathematics and Modelling in Modern Optics (to be published, 1989).

The research funded under Contract #AFOSR-88-0149 has been documented in the five papers:

K.E. Oughstun and S. Shen, "Velocity of Energy Transport for a Time-Harmonic Field in a Multiple Resonance Lorentz Medium," Journal of the Optical Society of America B, 5, 11, 2395-2398 (1988).

K.E. Oughstun, P. Wyns, and D.P. Foty, "Numerical Determination of the Signal Velocity in Dispersive Pulse Propagation," Journal of the Optical Society of America A, Feature Issue on Mathematics and Modelling in Modern Optics (to be published, 1989).

K.E. Oughstun and G.C. Sherman, "Uniform Asymptotic Description of Electromagnetic Pulse Propagation in a Linear Dispersive Medium with Absorption (the Lorentz Medium)," Journal of the Optical Society of America A (submitted).

K.E. Oughstun, J. Laurens, and P. Wyns, "Asymptotic Description of Ultrashort Electromagnetic Pulse Propagation in a Linear, Causally Dispersive Medium," URSI International Symposium on Electromagnetic Theory, Stockholm (to be published, 1989).

P. Wyns, D.P. Foty, and K.E. Oughstun, "On the Propagation of Short Optical Pulses in a Linear Dispersive Medium with Absorption," I.E.E.E. Journal of Quantum Electronics (submitted).

Reprints of these papers will be sent to you as each becomes available.

The research ~~funded by your office~~ on pulsed electromagnetic beam fields is nearing completion with some rather interesting results. In particular, the rigorous angular spectrum representation of pulsed beam fields has been found to differ from that given by the simpler plane-wave spectrum representation. This latter formulation [as given by W.H. Carter, "Electromagnetic Beam Fields," Optica Acta, 21, 871-892 (1974)] assumes the form of the propagated transverse field components for either the electric or magnetic field vector and then solves the Maxwell field equation for the remaining field components in a self-consistent manner. The rigorous derivation for a general pulsed electromagnetic beam field clearly shows that this assumption is valid only for very special cases of the spatial field distribution and polarization state.

I am presently pursuing the connection between the new rigorous formulation of pulsed electromagnetic beam field propagation in terms of the initial transverse field components with the previous angular spectrum formulation that is expressed in terms of the fundamental charge and current sources. Of further importance here is the consideration of the asymptotic representation of both the electric and magnetic field vectors in the dispersive medium as well as the associated Poynting vector for the generalized electromagnetic beam field case (for the pulsed plane wave field both field vectors can be derived from a single vector potential, as described in my previous published research). In turn, these considerations lead to the analysis of the dynamical energy absorption by the dispersive host medium under pulsed excitation. A detailed understanding of this problem is of significant physical importance. Research into these areas will continue as a by product of my main research direction into the asymptotic theory of pulsed electromagnetic beam propagation across a dielectric interface separating two dispersive media. The rigorous, formal solution to this problem has been obtained. However, before the entire asymptotic description can be completed, expressions for the reflection and transmission coefficients at a planar dielectric interface separating two causally dispersive media must be derived (quite surprisingly, these coefficients have only been derived for the case when one medium is causally dispersive).

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In conclusion, this research is proceeding along at a steady pace and is providing a rich variety of analytical results connected with the asymptotic theory of dispersive pulse propagation phenomena, as evidenced by the resulting publications. I expect that this formulational phase of the research will be completed by the end of the summer of 1989 and that the analysis will thereafter be focused on its application to a variety of problems of critical interest to our understanding of dispersive electromagnetic pulse propagation. Of course, this requires continuous funding from AFOSR in the future and I have attached a new proposal for your consideration.

Respectfully,

Kurt E. Oughstun

Kurt E. Oughstun

KEO/mep

cc: PKZA/Sandra E. Hudson
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